Outcome Analysis of Fixed Angle Locking Plate in Patella Fractures: A Single Centre Experience from North India

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Abstract

Background Tension band wiring supposedly is the most commonly used technique for displaced patella fractures, but is not effective in comminuted fractures and osteoporotic bones. It often leads to loosening of wires, dislocation of fracture, hardware problem and failure of osteosynthesis, resulting in knee stiffness and post-traumatic osteoarthritis. The aim of the study is to evaluate clinical outcome in patients with acute patella fractures (< 3 week) treated with unidirectional angle fixed low-profile titanium patella locking plate.

Materials and methods Twenty patients who presented with displaced patella fractures, aged between 18–70 years were included in the study. All fractures were reduced and fixed with unidirectional angle fixed stable low-profile titanium patella locking plate. Knee Range of motion and Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL) was used to evaluate the outcome.

Results We were able to achieve union in 19 out of 20 patients. One patient with comminuted patella fracture had failure of fixation, which was revised. Mean flexion at final follow-up was 124° (110°–130°) and none of the patients had extensor lag. The final radiograph revealed complete union in all patients.

Conclusion This technique offers an option of fixation in comminuted patella fracture and in osteoporotic individuals. It provides mechanical stability for fracture fixation resulting in anatomical reduction, good functional outcome, lower incidence of symptomatic implant or failure of osteosynthesis.

Keywords Patella fracture · Comminuted · Osteoporotic · Locking plate · Osteosynthesis

Introduction

Patella fracture accounts for about 1% of total skeletal fractures [1]. Patella plays a pivot role during knee flexion, squatting and kneeling, by increasing the effectiveness of quadriceps. Absolute articular reduction of patella fracture is necessary, since incongruity of as low as 2 mm results

in osteoarthritis of the knee joint, and hence osteosynthesis in comminuted patella fracture becomes challenging [2]. Tension band wiring has been a gold standard for treatment of transverse patella fracture for long, but over time it has been realized that there are some biomechanical limitations in this procedure, such as (a) tension band wiring works only during flexion and tends to fail under cyclic loading in extension, since fragmentary compression is neutralized [3]; (b) tension band wiring also demands an intact cortical buttress so that the tensile force of the quadriceps and patella tendon can be converted into compression at the articular surface, and this may be a reason for its failure in osteoporotic patella fracture [4]; (c) during fracture healing of patella, a three-dimensional complex force, i.e. bending, compression and tension, acts on the surface which necessitates accurate reduction and rigid fixation with restoration of articular surface and extensor mechanism for the fracture to heal with the best possible outcome; (d) the principle of tension band wiring does not

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apply in cases of comminuted and oblique fractures. These limitations necessitate the development of various other techniques for patella fracture fixation. Several studies and methods have been developed over years for better fixation and multiple plates have been developed such as mesh plate, hook plate, and mini plate. In our study, we used a unidirectional angle fixed stable low-profile titanium plate with multiple holes and undercut margins. These undercut margins and suture holes help in preserving small bony fragments for maximum anatomical reconstruction. The pre-contoured angle fixed plate (Fig. 1) properly recesses into the soft tissue, so that though the patella is subcutaneous, there is minimum wound problem and hardware complication. To our best knowledge, only one study has been published so far with such locking plate, in a German population between 2011 and 2015, and our study in an Indian population has given comparable results [5].

Materials and methods

This prospective observational study was conducted from 2018 to 2020, at a tertiary care centre in North India. Twenty patients fulfilling the inclusion criteria and giving consent were enrolled for the study, in a span of 6 months. The aim of the study was to analyse the outcome of patella fracture fixation with locking plate. Inclusion criteria for the study were: (1) age 18 years to 70 year, (2) acute fracture < 3 weeks old, (3) displaced transverse patella fracture, (4) comminuted patella fracture with articular incongruity or osteoporotic patella fracture.

Exclusion criteria were: (1) ipsilateral lower limb fracture around the knee, (2) open wound, (3) active local infection, (4) anterior knee soft tissue defects, (5) patella fracture post total knee replacement.

Technique

Standard patella fixation approach was used, keeping in mind to raise a thick flap to make sure the plate is covered with adequate soft tissue. In case of absence of any defect in the retinaculum due to injury, a 2 cm lateral arthrotomy was done to clinically palpate the articular reduction. Reduction was then secured with the help of k-wire and reduction clamp, following which the appropriate size star-shaped suture plate was chosen according to the fracture pattern and size of patella (Fig. 2a). The unidirectional angle fixed stable low-profile titanium patella locking plate by Arthrex (Germany) was used in all patients. It had undercut holes which were used in cases of comminuted fracture where small fragments could be held in reduction with the help of non-absorbable braided suture (Fig. 2b). After fixation of plate with locking screws, a finger is passed through lateral arthrotomy to check for any intra-articular penetration of the screws. Lateral view fluoroscopy is not so reliable owing to the triangular shape of the patella with the apex down, though skyline view may also be used alternatively. Stability of fixation is checked by knee flexion before closure (Fig. 2c).

Results

Over the course of 6 months, 53 patients presented with patella fracture at our trauma center, out of which 13 had undisplaced fracture pattern, 9 had associated ipsilateral lower limb fracture, 6 had open wound over patella and 1 had patella fracture post-total knee replacement. Out of the remaining 24 patients, 20 patients gave consent and were included in the prospective study.

Out of 20 patients, 3 were females and 17 were males. Average age was found to be 42 years. Thirteen patients

Fig. 1 a–c Fixed angle anatomically precontoured patella locking plate. Larger holes are for locking screws, while the smaller holes have undercut margins to help in fixation of smaller fragments using suture

Fig. 2 **a** Intra-operative image of fracture reduction with a clamp and stabilizing plate with k-wire before fixing it with locking screws. **b** Intra-operative image of comminuted patella fixed with locking plate

and non-absorbable braided suture. **c** Intra-operative image of checking stability of the construct by flexing the knee joint

had comminuted fracture and 7 had osteoporotic fracture. Average time of follow-up was 13 months (10 months to 21 months). Out of 20 patients, 19 achieved union (Fig. 3) except 1 (5%), with comminuted patella fracture had implant failure for which a revision surgery was done. Four out of 20 had their plates removed after union, Two of 20 (10%) had anterior knee pain and difficulty in kneeling due to implant impingement and the other two did not want to retain any hardware in their body, though the implant had no soft tissue irritation.

During follow-up, all the patients had full recovery of extensor mechanism (Fig. 4a). The Mean flexion achieved was 124°, 13 patients achieved flexion of minimum 130° (Fig. 4b) and the patient with implant failure on union achieved flexion of 110°. Most patients had no trouble in cross leg sitting (Fig. 4c). The influence of symptoms on daily activity is shown in Table 1 and the functional outcome in Table 2, both of which had been evaluated using the Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL). No patient had severe disability in daily activity

(Table 1) and the functional outcome of the patient was also well acceptable (Table 2). Eighteen out of 20 (90%) patients were pain free or slightly affected by pain in daily activity. Nineteen out of 20 (95%) did not have knee stiffness. Seventeen out of 20 (85%) did not have problem in walking. Four out of 20 (20%) patients had difficulty in kneeling on the front. None had difficulty in standing. One patient who underwent second surgery due to implant failure had some restrictions in daily activity and also complained of symptomatic pain. The average ADL score was 86%, which means the function of the patient's knee in daily life returned to an average of 86% to their function before trauma.

Discussion

In this study we have done a prospective outcome analysis of patella fracture using unidirectional angle fixed stable low-profile titanium patella locking plate fixation and compared it with the available relevant data of tension band wiring.

Fig. 3 **a** Pre-op radiology of a patient with comminuted patella fracture. **b** Post-op radiology of fixation with patella locking plate and braided suture

Fig. 4 a–c Functional outcome of locking plate post-union. **a** Presence of complete extension which was a consistent finding in all patients. **b** Most patients were able to achieve full flexion and do squat. **c** Most patients had no problem in cross leg sitting

Table 1 Influence of symptoms on daily activity (KOS-ADL)

	I do not have the symptom	I have the symptom, but it does not affect my activity	The symptom affects my activity slightly	The symptom affects my activity moderately	The symptom affects my activity severely	The symptom prevents me from all daily activity
Pain	10	4	4	1	1	0
Stiffness	13	3	3	1	0	0
Swelling	13	4	2	1	0	0
Slipping	11	4	3	3	0	0
Buckling	14	2	2	2	0	0
Weakness	18	1	1	0	0	0

Tension band wiring has prerequisites like transverse fracture pattern and intact cortical buttress to facilitate union [6]. The poor outcome of tension band wiring in comminuted displaced patella fracture led to development of various other methods for treatment of patella fracture such as basket plate, hook plate, and mini plate [7]. In our study, we used an anatomically pre-bend plate in all 20 patients, out of which only 1 patient underwent complication of implant failure (Fig. 5), i.e. 5% as compared to 20–30% failure rate in tension band wiring. Smith et al. reported that a significant displacement was seen during the perioperative period in

as much as 22% patients treated with tension band wiring. This problem was overcome by the use of a more rigid construct like locking plate [8]. Dy et al. in his meta-analysis have reported that 34% patients underwent re-operation after tension band wiring as compared to 5% (1 in 20) by using locking plate, as seen in our study [9].

The Superiority of locking plate to tension band wiring has been proven in a biomechanical test by Wurm et al. [10] and a cadaveric study by Thelen et al. [11, 12]. This superiority has enabled us to engage patients with early rehabilitation protocol, thus avoiding problems of knee stiffness,

Table 2 Functional limitations with activities of daily living (KOS-ADL)

	Activity is not difficult	Activity is minimally difficult	Activity is somewhat difficult	Activity is fairly difficult	Activity is very difficult	I am unable to do the activity
Walk	13	4	2	1	0	0
Go upstairs	12	3	3	1	1	0
Go downstairs	10	3	4	2	1	0
Stand	15	3	2	0	0	0
Kneel on the front	8	6	2	1	2	1
Squat	11	5	1	2	1	0
Sit with your knee bent	12	4	3	1	0	0
Rise from a chair	13	3	2	2	0	0

Scoring: each row has a maximum of 5 points and the lowest of 0 points, 5 being given to the best outcome and 0 to the worst. The first column is scored 5 points, followed in successive columns by scores of 4, 3, 2, 1, and 0 for the last column. The total points for all patients was calculated which came out to be 1205, and then divided by 70 (maximum points for individual patient)*20 (total no. of patients in study). The average ADLS score calculated was $1205/1400 \times 100 = 86\%$

Fig. 5 Radiology of the patient presenting 2 months post-fixation with anterior knee pain and extensor lag, showing failure of implant

which is a well-documented complication in tension band wiring. We recommended our patients to start immediate weight bearing, passive flexion of up to 90° with brace support in the initial 2 weeks and then 120° degree passive knee flexion over the next 4 weeks.

Even after use of advanced techniques and early wound healing methods of tension band wiring, the subcutaneous nature of patella makes symptomatic implant as one of the most commonly encountered problems. Symptomatic implant is recorded in up to 60% patients with tension band wiring as compared to only 10% (considering patients' subjective symptom, but could be even less if it was because of cicatrix) in our method of fixation [13]. Other dreaded complications of tension band wiring like osteoarthritis, marginal fractures [14], and wire breakage [15] have also been well documented and can be easily avoidable using a locking plate. It provides excellent compression and a rigid construct along with the undercut surface of plate, which aids in fixing larger fragments with non-absorbable braided suture.

Our method of fixation also permits direct clinical visualization of the articular surface which helps in a possible better outcome and avoids development of patella–femoral joint arthritis. An additional surgery was done in four patients for implant removal, only after at least 9 months of fixation, out of which only 2 had impingement while kneeling in the front and the other 2 desired not to retain any metal implant in their body. Similar tendencies have also been reported in other implants which maybe acknowledged to the social and psychological factor as opposed to irritation by implant [16].

In our study, a good functional recovery of range of motion was noted, with 124° as an average and 13 patients achieving at least 130° . Only one patient had flexion of 110° ; this patient had undergone a revision operation due to implant failure and was revised with addition wire circlage and repositioning of the plate. Most of the patients were symptom free, and only two of them (10%) had moderate to severe pain as compared to 30–40% patients who have residual pain when fixation was done by tension band wiring or screw fixation [1]. Even in activities of daily life, most of the patients were asymptomatic. Three patients had severe problem in kneeling to the front, and two of them had their implant removed but did not show much benefit post-implant removal. Kneeling remained a problem for them even in further follow-ups, concluding that pain in kneeling was not because of the implant but because of the scar of the healed wound.

Wurm et al. [5] had done a study in a German population, using a similar plate. The average age in their study was 56 years as compared to 42 years in our study. The male:female ratio in their study was 0.67 as compared to 5.67 in our study, mainly because of the larger number of road traffic accidents in our country. They also included patients with periprosthetic patella fracture and failed tension band wiring. They achieved a range of motion of 127° and complication rate of 6%. The average ADL score in their study was

77% as compared to 86% in our study. The results are almost reproducible in the Indian population, except for a better functional outcome in our study which may be because of inclusion of acute fractures only. They had a comparatively larger portion of patient having problem kneeling and squatting, which can be accountable to multiple operations a few patients underwent in the study and thus a larger anterior knee scar.

The advantages of plating over tension band wiring are that plating can be used in comminuted, oblique and osteoporotic patella fractures. It helps in preserving maximum bone, aiding in anatomical reduction which is important for normal quadriceps excursion. It has minimum wound problems, lesser hardware complication, reduced incidence of knee stiffness due to early rehabilitation protocol, and better visualized articular congruency especially helpful in comminuted and osteoporotic patella fracture.

The disadvantages of using locking plate are mainly the hardware cost, rigid fixation in compression might cause overtensioning of the patellar tendon, and the screws might penetrate intra-articularly if proper precautions are not taken.

Conclusions

Based on our results, we conclude that angle fixed low-profile patella locking plate is a more bone-preserving and better implant for treatment of patella fractures. This technique offers an option of fixation in comminuted patella fracture and fractured patella in osteoporotic individuals. It provides mechanical stability for fracture fixation, resulting in anatomical reduction, good functional outcome and decreased incidence of symptomatic implant or failure of osteosynthesis. The proven better biomechanical strength of the same has helped in early rehabilitation and return of patients back to their normal daily lifestyle.

Limitations

This was a prospective cross-sectional analytical study and direct comparison of the patella plate fixation with other modalities of treatment was not done. The results of the present study were compared with already existing data in the literature, which might have caused some bias to finding inferior outcomes of tension band wiring. The inclusion criteria of the current study included only acute fractures (< 3 weeks) and primary fixation, and the use of a similar method in chronic or failed osteosynthesis by other methods may not give similar results. This study had a small sample size; further studies with bigger sample size and comparison with other modalities will aid in providing better comparative results.

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Compliance with Ethical Standards

Conflict of interest The author(s) have no conflicts of interest to declare.

Ethical standard statement All procedures performed in this study involving human participants were in accordance with the ethical standards of the Institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was taken from all patients.

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